FIG.1

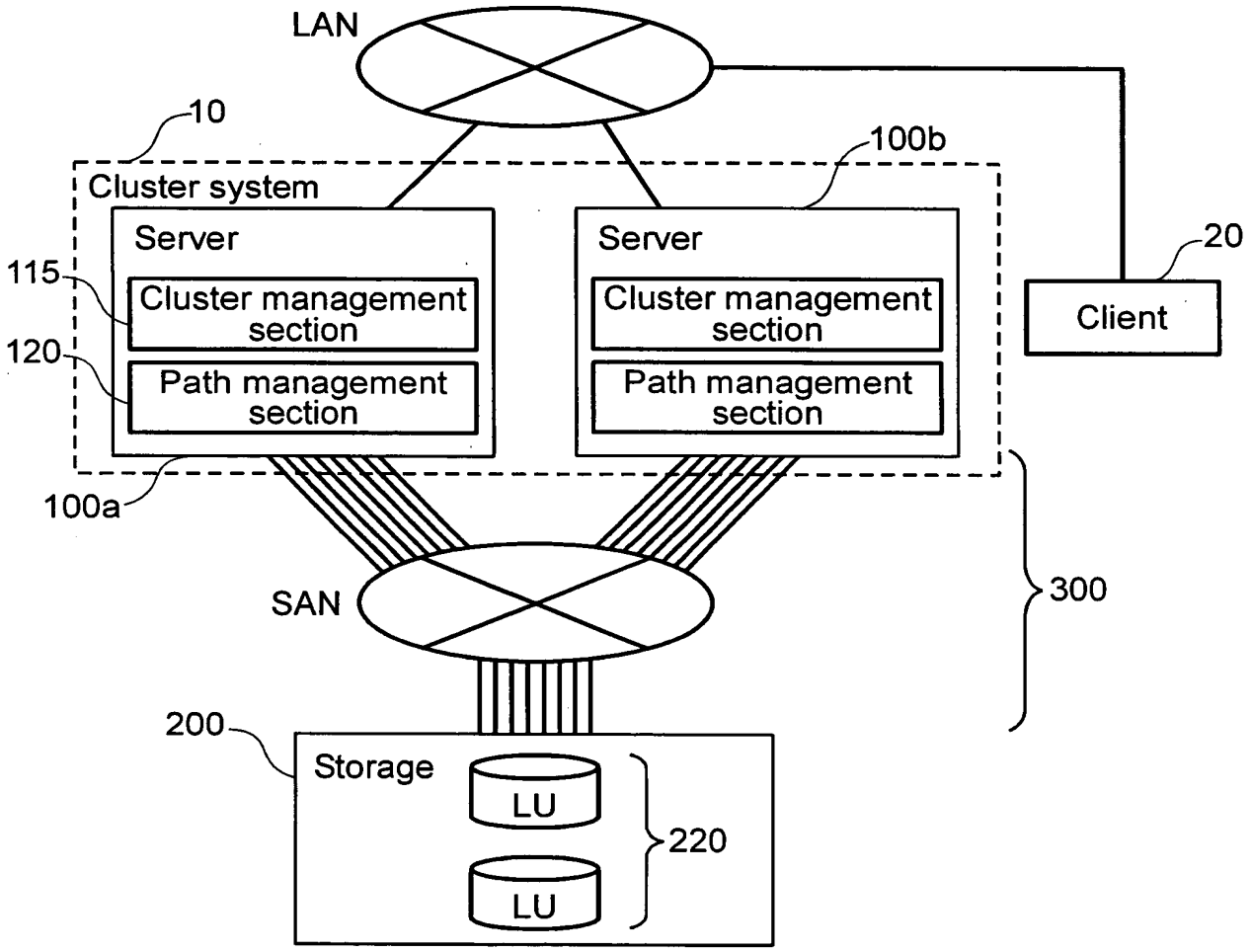

LAN
10
Cluster system
100b
Server
Server
115
Cluster management section
Cluster management section
120
Path management section
Path management section
20
Client
100a
300
SAN
200
Storage
LU
LU
220

FIG.2

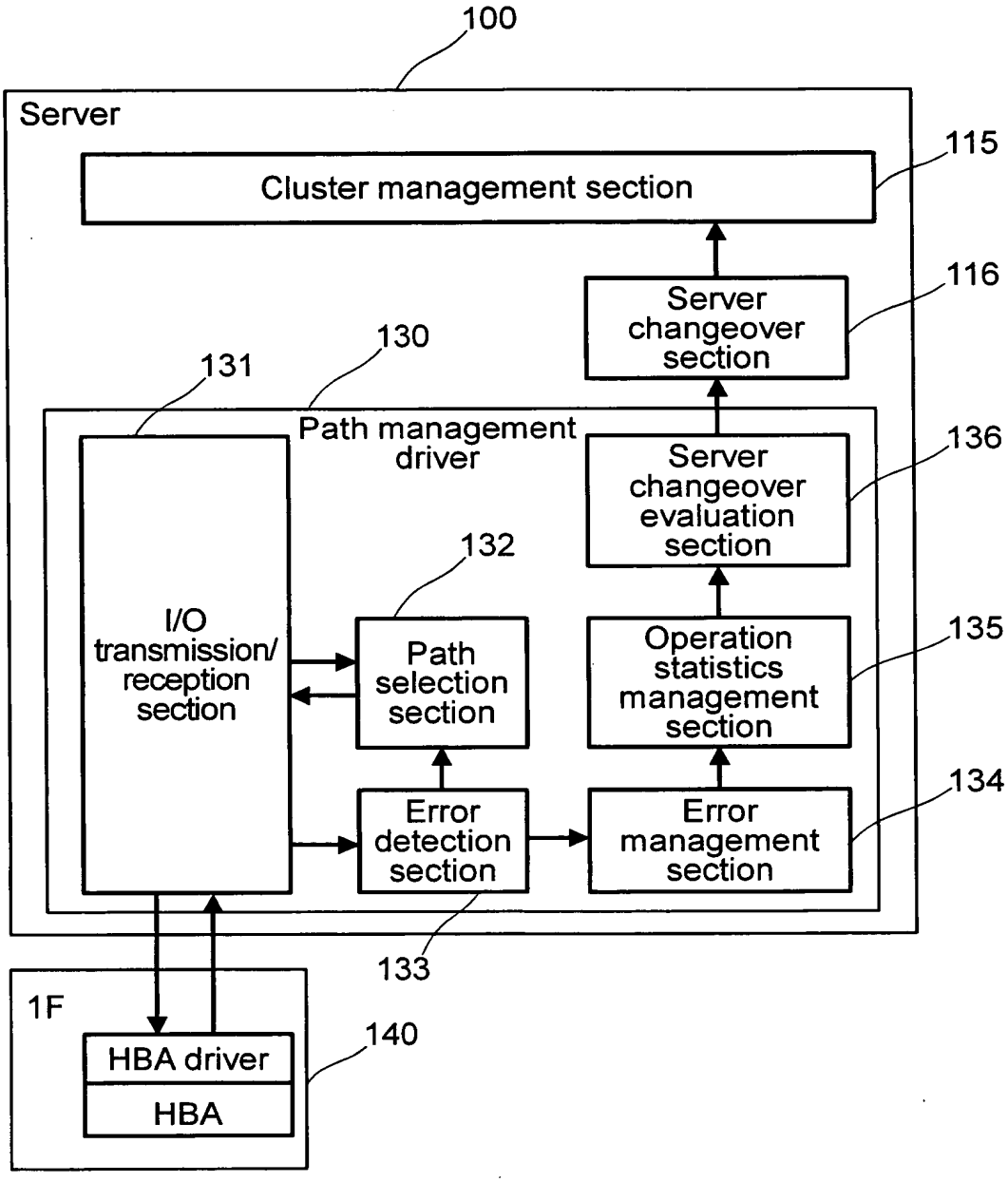

100
Server
115
Cluster management section
116
Server changeover section
130
131
Path management driver
136
Server changeover evaluation section
132
I/O transmission/ reception section
Path selection section
Operation statistics management section
135
134
Error detection section
Error management section
133
1F
140
HBA driver
HBA

FIG.3

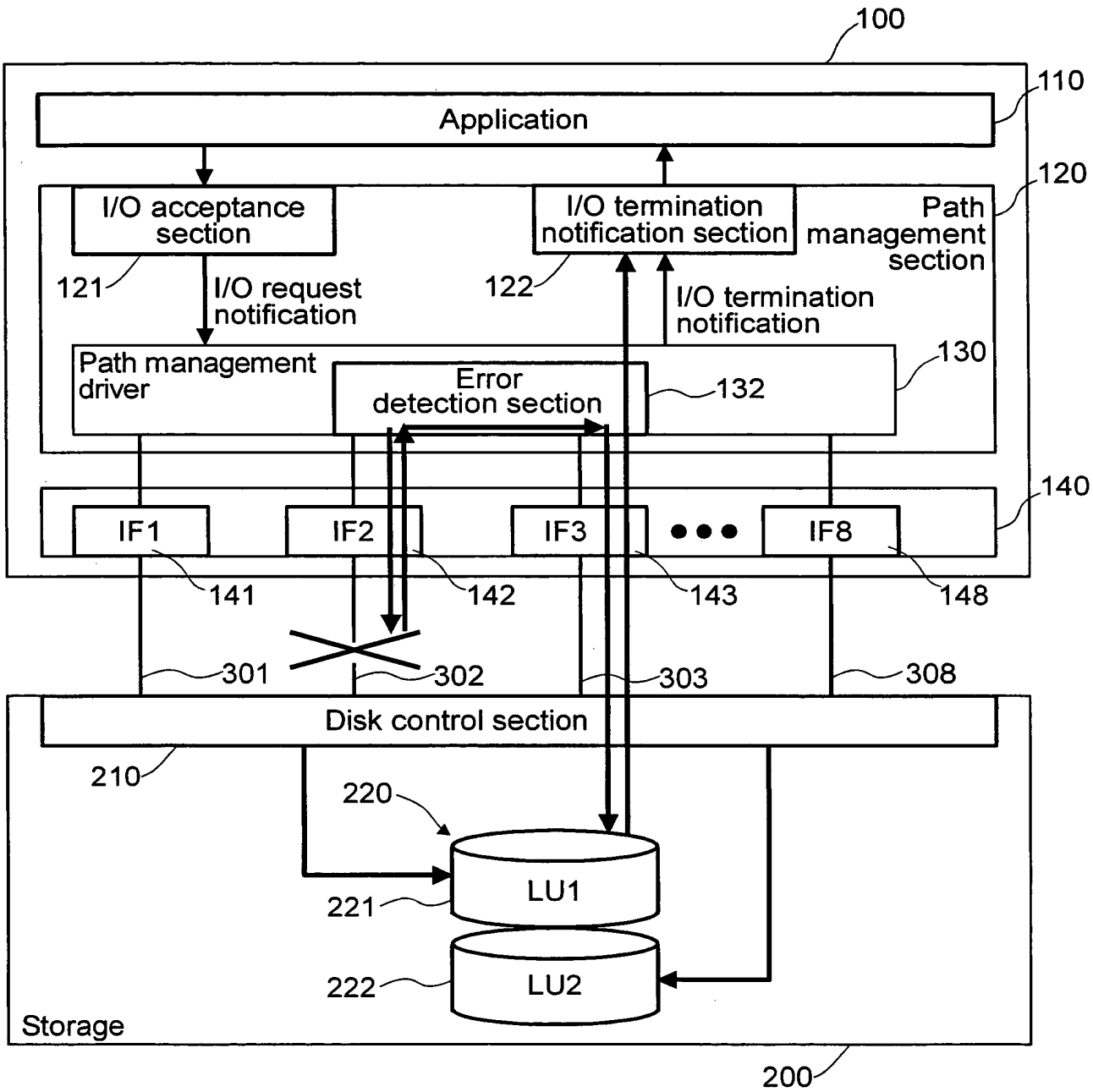

100
110
Application
120
I/O acceptance section
121
I/O request notification
I/O termination notification section
122
I/O termination notification
Path management section
130
Path management driver
Error detection section
132
140
IF1
IF2
IF3
IF8
141
142
143
148
301
302
303
308
Disk control section
210
220
LU1
221
LU2
222
Storage
200

FIG.4

Case	Path1	Path2	Path3	Path4	Path5	Path6	Path7	Path8
1	Instantaneous break	Instantaneous break	Instantaneous break	Instantaneous break	Normal	Normal	Normal	Normal
2	Accumulation	Accumulation	Accumulation	Accumulation	Accumulation	Accumulation	Normal	Normal
3	Performance	Performance	Performance	Performance	Performance	Performance	Performance	Normal

FIG.5

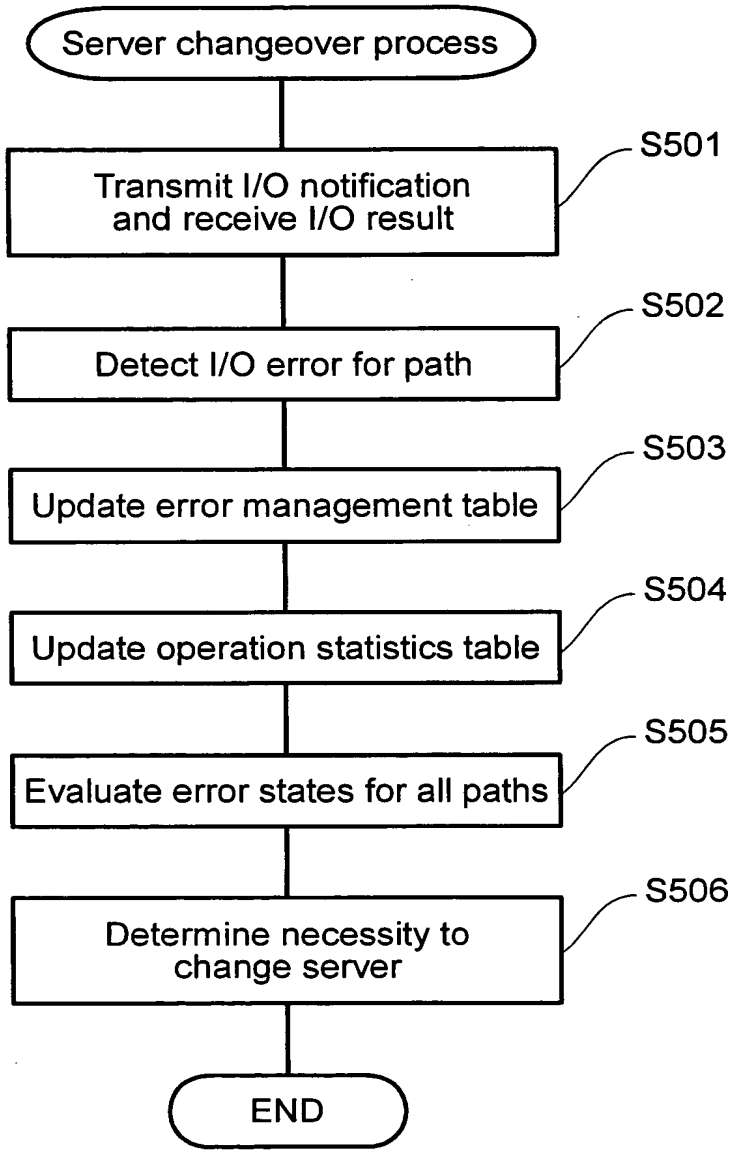

Server changeover process
Transmit I/O notification and receive I/O result
S501
Detect I/O error for path
S502
Update error management table
S503
Update operation statistics table
S504
Evaluate error states for all paths
S505
Determine necessity to change server
S506
END

FIG.6

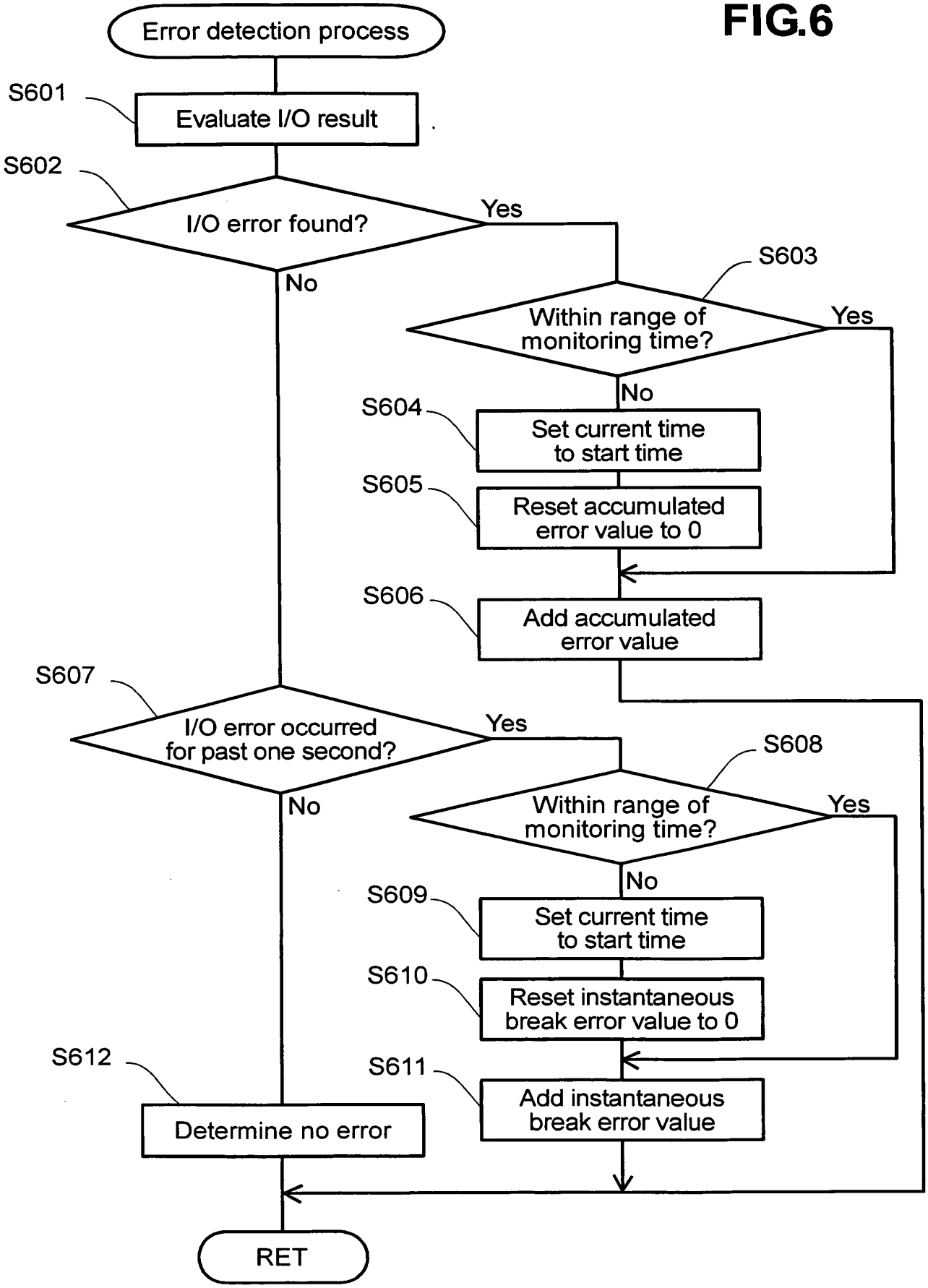

Error detection process
S601
Evaluate I/O result
S602
I/O error found?
Yes
No
S603
Within range of monitoring time?
Yes
No
S604
Set current time to start time
S605
Reset accumulated error value to 0
S606
Add accumulated error value
S607
I/O error occurred for past one second?
Yes
No
S608
Within range of monitoring time?
Yes
No
S609
Set current time to start time
S610
Reset instantaneous break error value to 0
S611
Add instantaneous break error value
S612
Determine no error
RET

FIG.7

Path error management table

Path	Error type	Start time	Monitoring period	Criterion	Detected value
1	Instantaneous break error	2003/9/1 10:20:30.020	30	20	19
	Accumulation error	2003/9/1 10:20:30.020	30	50	30
	Performance error	2003/9/1 10:20:30.020	-	1	0
2	Instantaneous break error	2003/9/1 10:20:30.020	30	20	0
	Accumulation error	2003/9/1 10:20:30.020	30	50	0
	Performance error	2003/9/1 10:20:30.020	-	1	0
3	⋮				

FIG.8

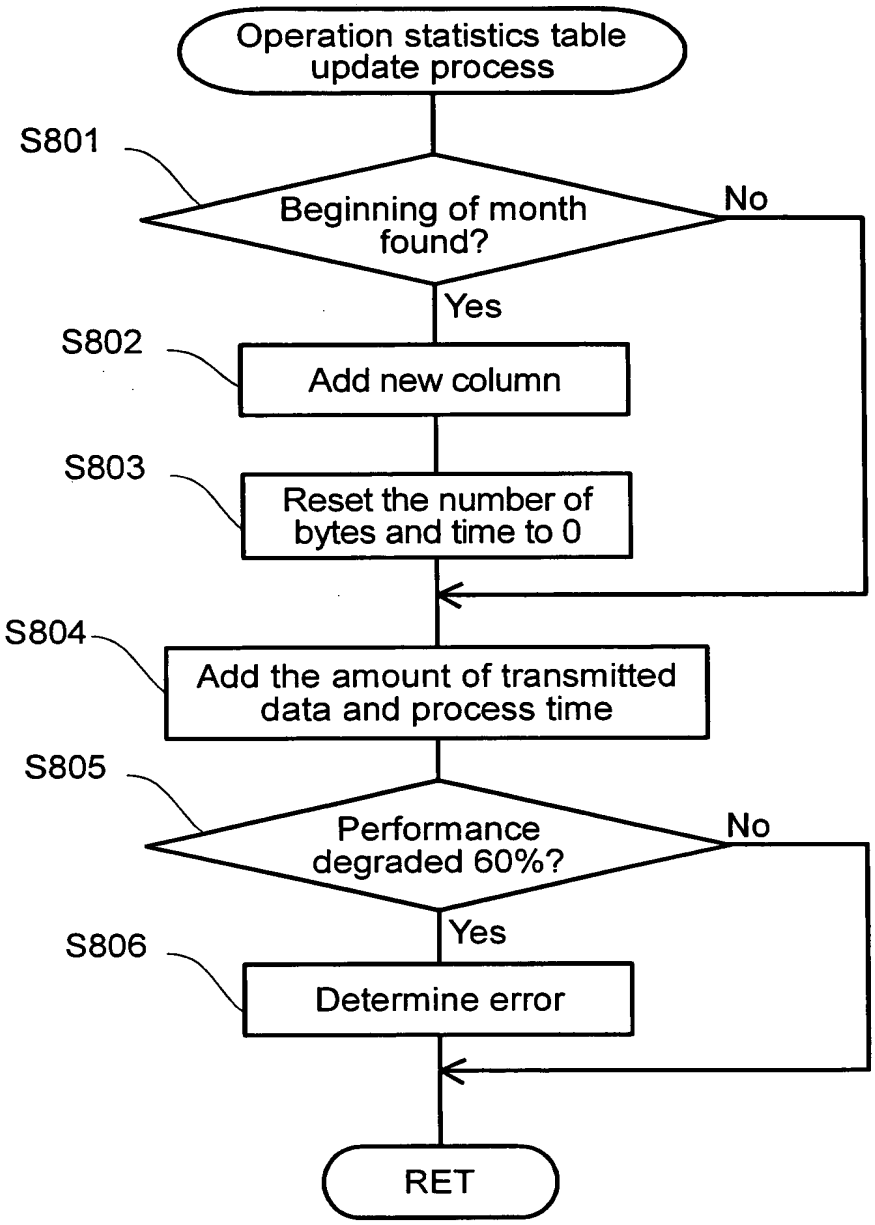

Operation statistics table update process
S801
Beginning of month found?
No
Yes
S802
Add new column
S803
Reset the number of bytes and time to 0
S804
Add the amount of transmitted data and process time
S805
Performance degraded 60%?
No
Yes
S806
Determine error
RET

FIG.9

Operation statistics management table

Path	2003/8/1		2003/9/1		2003/10/1		2003/11/1	
	Bytes	Time	Bytes	Time	Bytes	Time	Bytes	Time
1	100	1000	90	1000	80	1000	50	1000
2	100	1000	90	1000	80	1000	50	1000
3	100	1000	90	1000	80	1000	50	1000
4	100	1000	90	1000	80	1000	50	1000
5	100	1000	90	1000	80	1000	50	1000
6	100	1000	90	1000	80	1000	50	1000
7	100	1000	90	1000	90	1000	90	1000
8	100	1000	90	1000	90	1000	90	1000

FIG.10

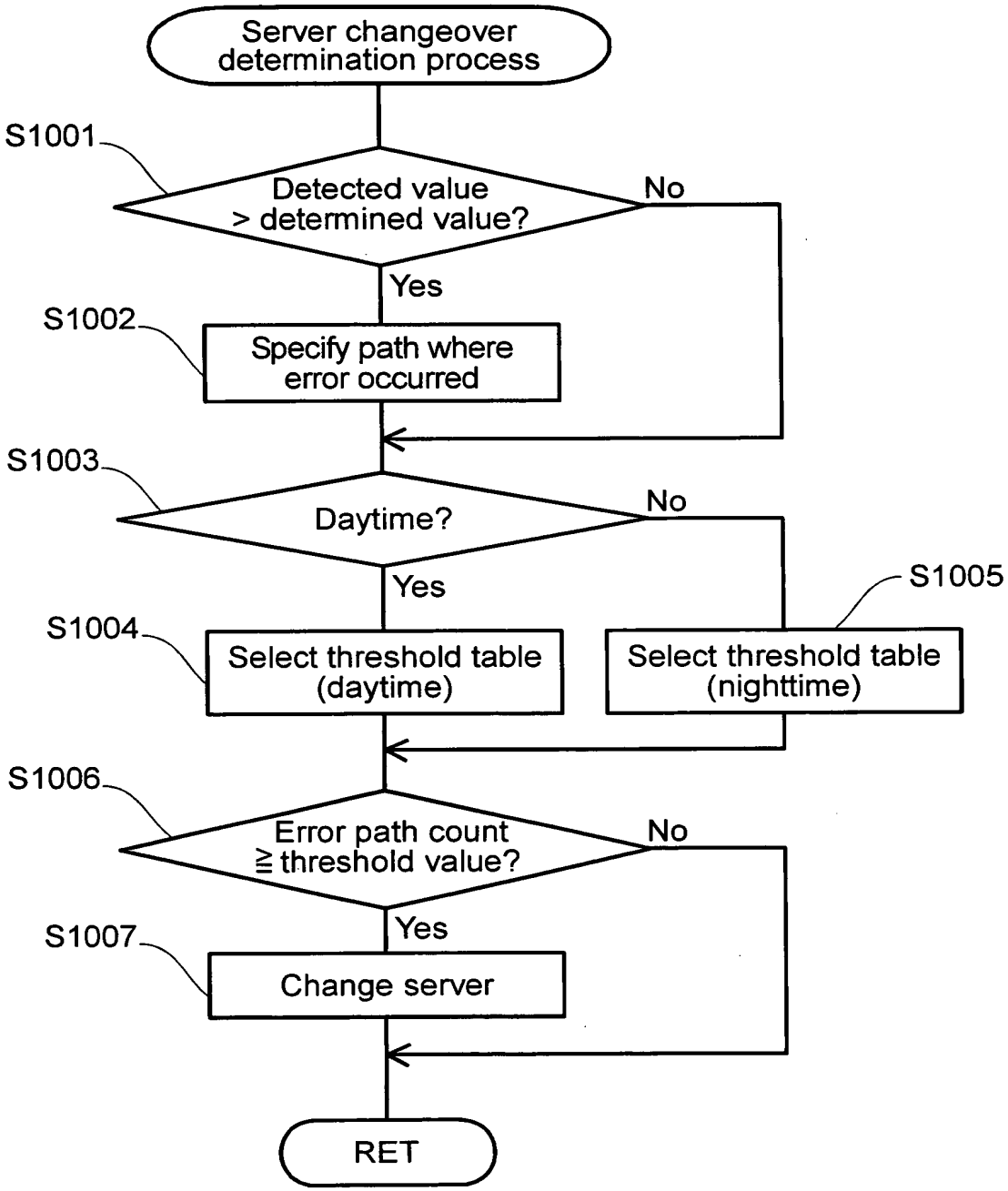

Server changeover determination process
S1001
Detected value > determined value?
No
Yes
S1002
Specify path where error occurred
S1003
Daytime?
No
Yes
S1005
S1004
Select threshold table (daytime)
Select threshold table (nighttime)
S1006
Error path count ≧ threshold value?
No
Yes
S1007
Change server
RET

FIG.11

Sever changeover threshold value table

Error type	Ratio to total paths	
	Daytime	Nighttime
Instantaneous break error	50%	40%
Accumulation error	80%	70%
Performance error	90%	80%

FIG.12

Case	Path1	Path2	Path3	Path4	Path5	Path6	Path7	Path8
4	Instantaneous break	Instantaneous break	Instantaneous break	Accumulation	Accumulation	Normal	Normal	Normal
5	Accumulation	Accumulation	Accumulation	Performance	Performance	Performance	Performance	Normal
6	Instantaneous break	Instantaneous break	Accumulation	Accumulation	Performance	Performance	Normal	Normal

FIG.13

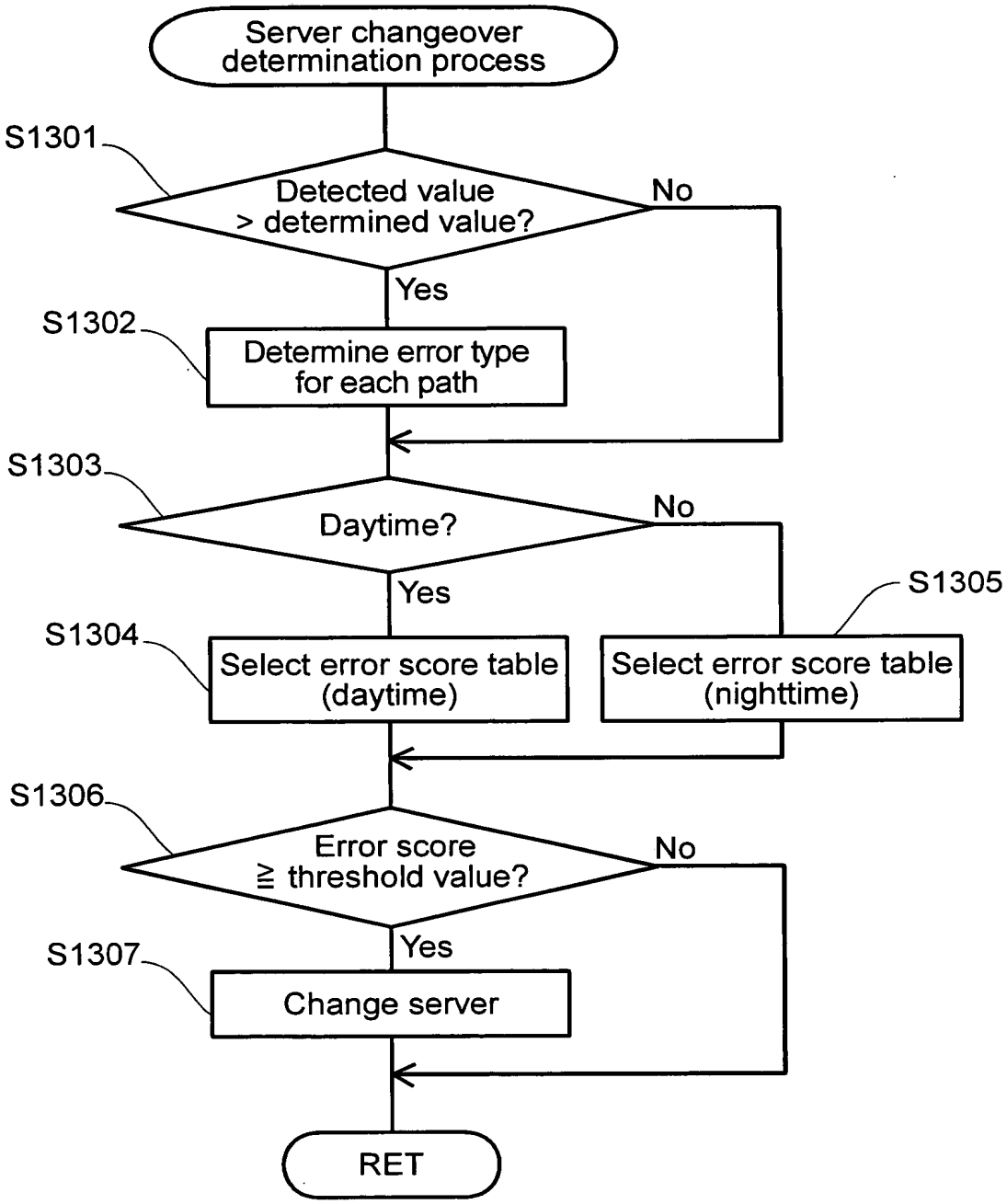
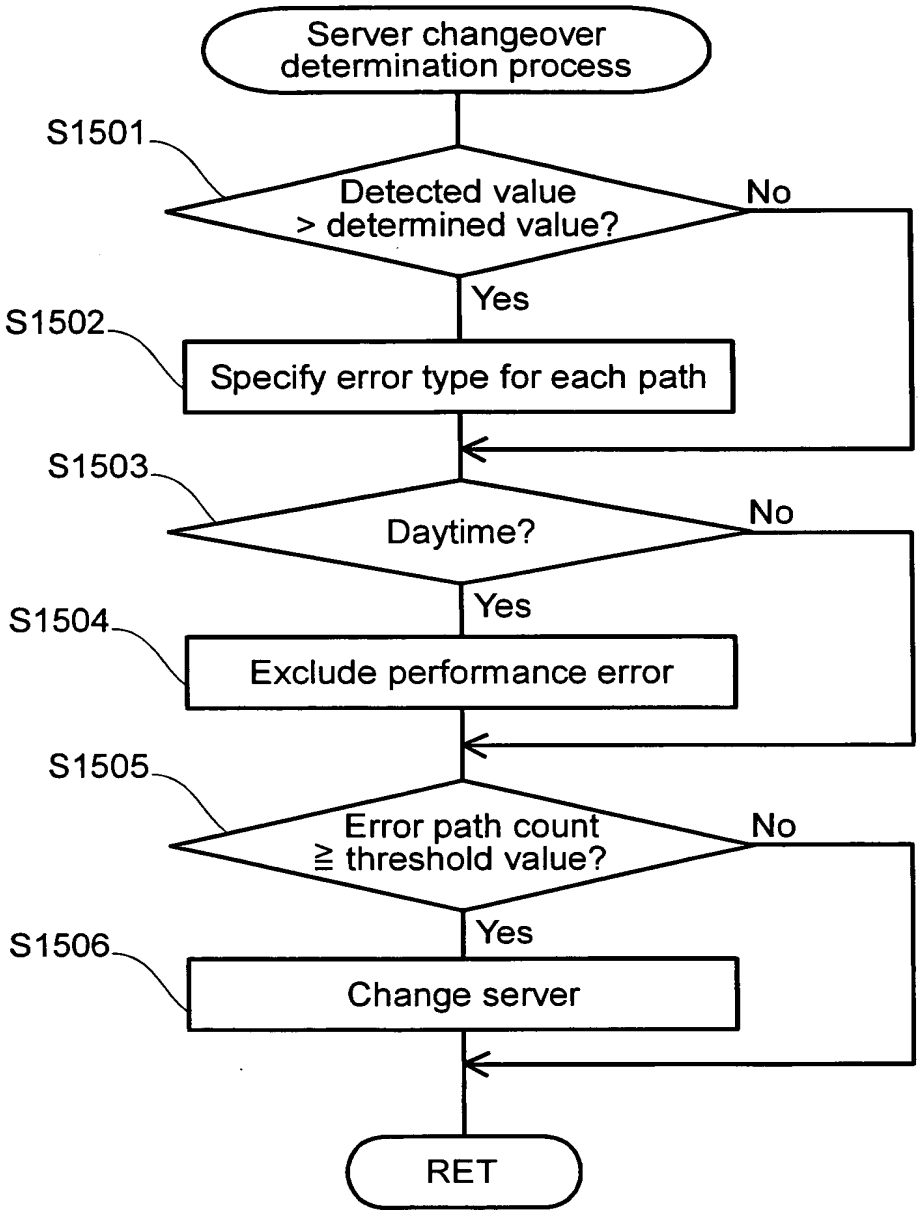

Server changeover determination process
S1301
Detected value > determined value?
No
Yes
S1302
Determine error type for each path
S1303
Daytime?
No
Yes
S1305
S1304
Select error score table (daytime)
Select error score table (nighttime)
S1306
Error score ≧ threshold value?
No
Yes
S1307
Change server
RET

FIG.14

Error score table

Error type	Score	
	Daytime (1)	Nighttime (1.1)
Instantaneous break error	2	2.2
Accumulation error	1.43	1.57
Performance error	1.25	1.38

FIG.15


Server changeover determination process
S1501
Detected value > determined value?
No
Yes
S1502
Specify error type for each path
S1503
Daytime?
No
Yes
S1504
Exclude performance error
S1505
Error path count ≧ threshold value?
No
Yes
S1506
Change server
RET